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(54) **Improvements in or relating to methods of manufacturing stator windings for three-phase generators**

(57) A method of winding stator windings of three-phase generators is disclosed, particularly for use on an automatic winding machine, in which the starts of the windings required for the three phases are introduced into adjacent slots in the stator, successive partial windings of a winding are wound in alternate directions and, after winding a partial winding 43 of a first phase winding 40, the corresponding partial windings 44, 45 of the other two phase windings 41, 42 are wound before the next partial winding 46 of the first phase winding is wound, and so on, and the start and end W, Z of one phase winding are transposed electrically when the windings are inter-connected after completion of winding: an optimum filling factor of the slots similar to that of a two-layer winding can be obtained.

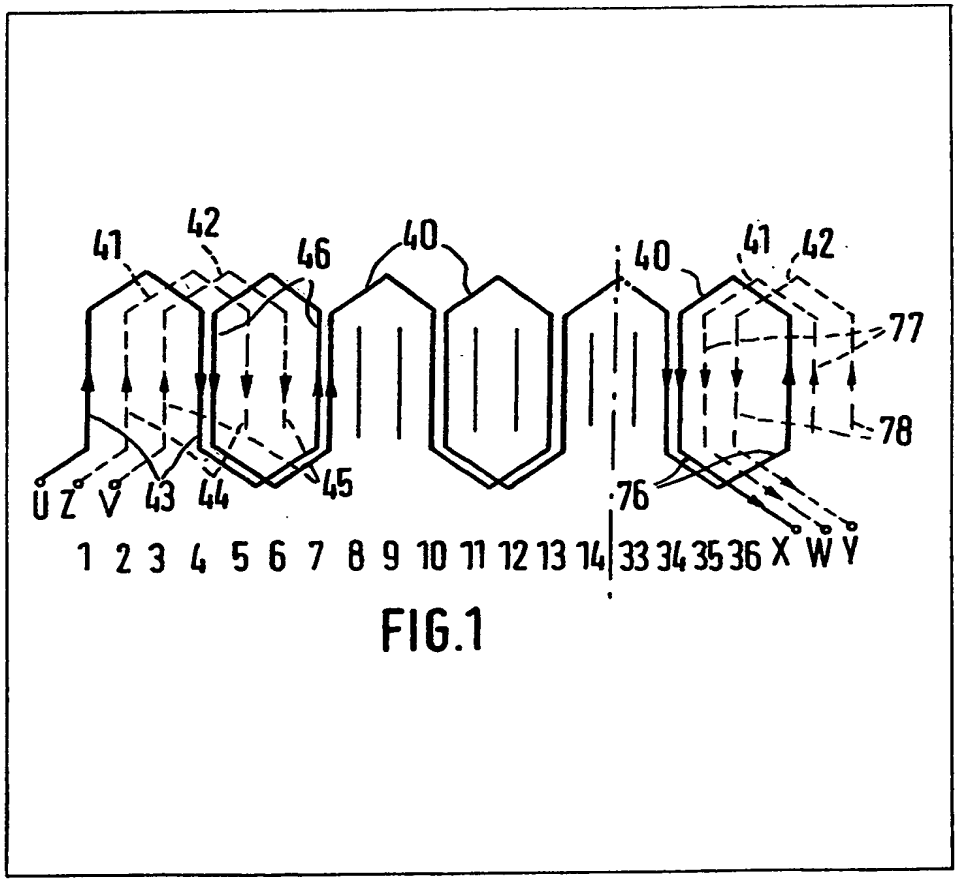

FIG.1

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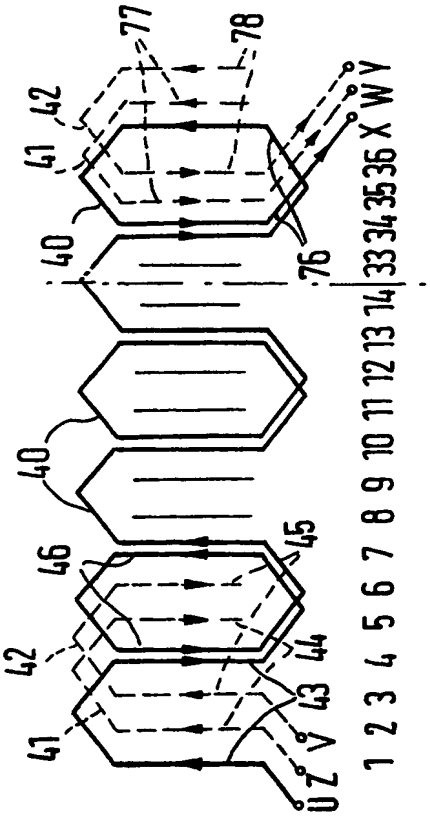

FIG.1

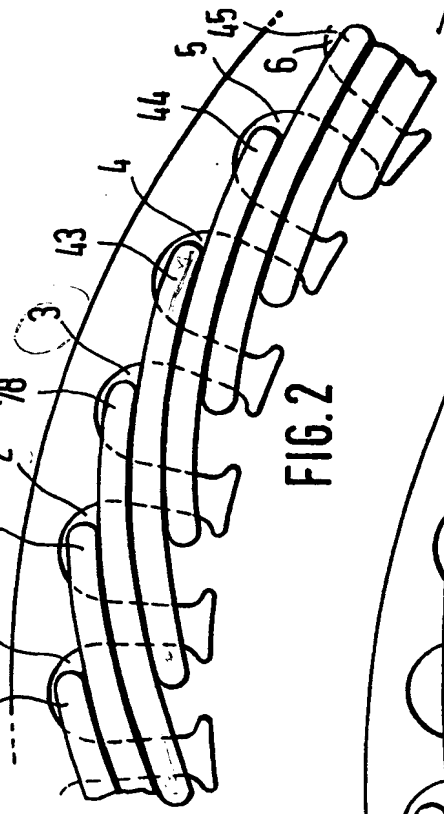

FIG.2

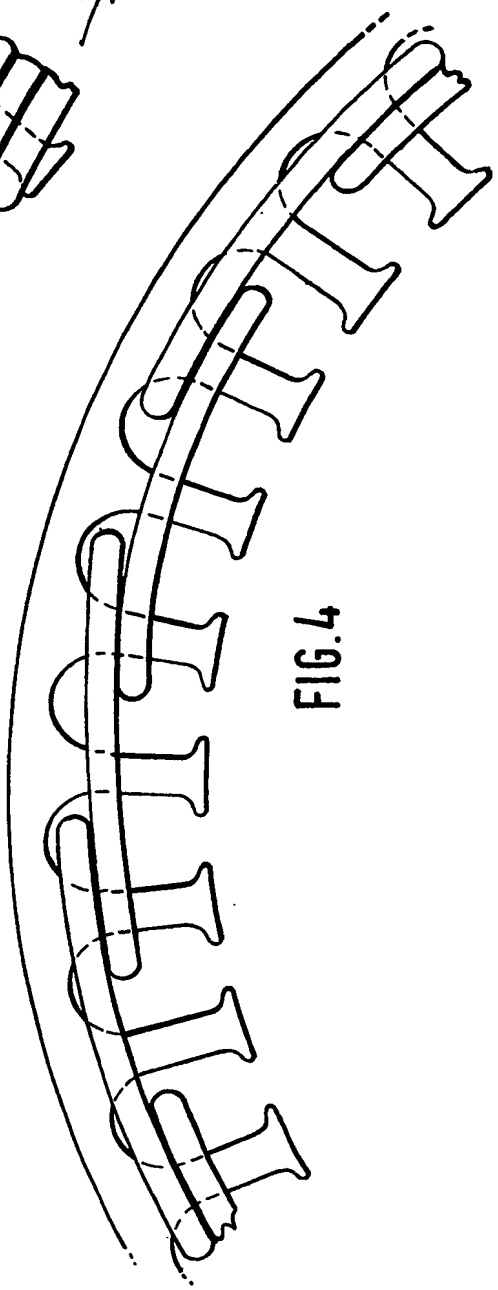

FIG.4

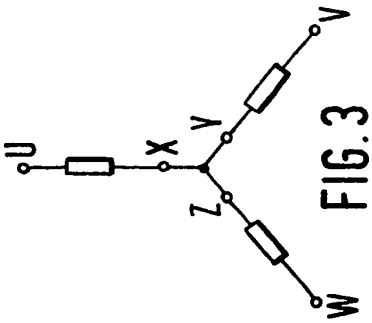

FIG.3

SPECIFICATION

Improvements in or relating to methods of manufacturing stator windings for three-phase generators

The present invention relates to methods of manufacturing stator windings for three-phase generators.

One method of manufacturing stator windings for three-phase generators, particularly a method for use on an automatic winding machine, is disclosed, for example, in German Offenlegungsschrift No. 2,750,112. In this known mechanical method, the filling factor in the slots of the stator is increased, relative to a conventional lap winding, or wave winding by means of a special winding mechanism. However, the filling factor is further improved by the so-called two-layer windings which are wound manually and in which the partial windings are superimposed one on the other in a manner like fish scales.

According to the present invention there is provided a method of manufacturing stator windings for three-phase generators, particularly a method for use on an automatic winding machine, in which method the winding for each phase comprises a plurality of partial windings each having at least one turn, the starts of the windings required for the three phases are introduced into adjacent slots in the stator, the partial windings of each winding are successively wound in alternate directions with two other slots located between the two slots into which coil-sides of a partial winding are introduced, and, after a partial winding of a first phase winding has been wound, the corresponding partial windings of the other two phase windings are wound before the next partial winding of the first phase winding is wound and the start and end of one phase winding are electrically transposed when the windings are interconnected after completion of winding.

A method in accordance with the present invention can have the advantage that an arrangement of the partial windings similar to that of a two-layer winding can be obtained by a method which can be performed in a simple manner by a machine. An optimum filling factor can result in the case of small end-turns between coil-sides.

The invention will be further described by way of example with reference to the accompanying drawings in which:—

Fig. 1 is a winding diagram of one embodiment of the invention,

Fig. 2 is a partial end view of a resultant stator showing the relative positions of end-turns and coil-sides and stator slots,

Fig. 3 is a circuit diagram showing the interconnection of the windings to form a three-phase generator, and

Fig. 4 is a detail view corresponding to Fig. 2 showing the positions of end-turns and coil sides of a known wave winding.

The winding diagram of Fig. 1 is based on a twelve pole three-phase stator having thirty-six slots. This results in twelve partial windings (and consequently also twelve coil sides) for each phase. In order to simplify the illustration, only slots 1 to 14 and 33 to 36 of the thirty-six slots are shown, and only one winding 40 associated with one phase is shown in its entirety. The starts and ends of the other two windings 41, 42 associated with the other two phases are shown by broken lines. The winding method is performed in the following manner:

The winding operation is commenced with the first winding 40 and coil-sides of the first partial winding 43 are introduced into the slots 1 and 4 by winding in a clockwise direction. The corresponding coil-sides of the first partial windings 44, 45 of the other two windings 41, 42 are subsequently introduced into the slots 2 and 5 and 3 and 6 respectively in a corresponding manner. The coil-sides of the second component partial winding 46 of the winding 40 are subsequently introduced into the slots 7 and 4 by winding in an anti-clockwise direction, in turn followed by the corresponding partial windings of the windings 41 and 42. This procedure is continued, that is to say, windings are wound alternately in a clockwise direction and in an anti-clockwise direction in the case of each winding, the three corresponding partial windings of the three phases being wound successively. In order to simplify the illustration, each partial winding is illustrated as only one turn. It will be appreciated that the number of turns is optional and depends upon the spatial conditions and the electrical requirements. The winding method which has been described results in an arrangement of the end-turns between the coil-sides as shown in Fig. 2, that is to say, these coil-sides and end-turns are superimposed one on the other in a manner like fish scales, thus resulting in a very large filling factor in the slots.

The starts of the three windings 40 to 42 are designated U, Z, V and their ends are designated X, W, Y. The individual windings are then interconnected in a known configuration, such as a star circuit as shown in Fig. 3. The winding ends X, Y, Z are usually interconnected to form a common star point. An electrical angle of 120 degrees relative to the other phases is produced by electrical transposition of the start and the end of the second winding 41 commencing in slot 2. Thus, an electrical angle of 120 degrees exists between all three windings. Thus, the star point is formed by the start of the second winding and the ends of the first and third windings.

If it is also desired to retain the uniform scale-like pattern of the end-turns at the start or the end of the winding, only one coil-side of each of the partial windings 43 to 45 is introduced into the slots 4 to 6 at the commencement of the winding operation. The oppositely located coil-sides of these partial windings are first located outside the slots 1 to 3. In the same manner as in the known two-layer winding method, the free ends of the windings 43 to 45 are folded into the slots after

the last partial windings 76 to 78 have been wound. This results in a completely uniform end-turn pattern. It will be appreciated that, in a simplified method, if one accepts a slight disorder in the end-turn pattern, only half the coil-side of the winding 43 or only half the coil-sides of the windings 43 and 44 can be introduced at the commencement of winding.

Fig. 4 shows the arrangement of the end-turns between coil-sides in the known wave winding. The more unfavourable filling factor is clearly shown, so that a larger volume is required for the same generator output.

CLAIMS

1. A method of manufacturing stator windings for three-phase generators, particularly a method for use on an automatic winding machine, in which method the winding for each phase comprises a plurality of partial windings each having at least one turn, the starts of the windings required for the three phases are introduced into adjacent slots in the stator, the partial windings of each winding are successively wound in alternate directions with two other slots located between the two slots into which coil-sides of a partial winding are introduced, and after a partial winding of a first phase winding has been wound, the corresponding partial windings of the other two phase windings are wound before the next partial winding of the first phase winding is wound, and the start and end of one phase winding are electrically transposed when the windings are interconnected after completion of winding.

2. A method as claimed in claim 1, in which coil-sides of the last partial windings of each of the windings are laid below the respective coil-sides of the first partial windings.

3. A method as claimed in claim 2, in which when winding the first partial windings only one respective coil-side of each partial winding is introduced into one respective slot and the other coil-sides of the first partial windings are introduced into the other respective slots by folding in only after the last partial windings have been wound.

4. A method of manufacturing stator windings for three-phase generators, substantially as hereinbefore particularly described with reference to and as illustrated in Figs. 1 to 3 of the accompanying drawings.

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